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BHS Exhibit 36
9-29-83, TL

LABORATORY PERMEABILITY/COMPATIBILITY TESTS
BOB'S HOME SERVICE

INTRODUCTION

Three permeability and two leachate/soil compatibility tests were performed on soil specimens from the unoxidized zone. The soil specimens were trimmed from Shelby-tube soil samples which were obtained from borings from the floor of the progressive trench area. The boring locations are shown in Figure 1.

The procedures used to perform the permeability tests were consistent with the methodology specified by the Army Corps of Engineers (1970), for "Permeability Tests with Back Pressure." The leachate/soil compatibility tests were performed in an identical manner to the permeability tests except that leachate from cell 1-N was substituted for ground water as the permeant in the test.

SOIL/LEACHATE COMPATIBILITY

All previous permeability tests, both in the laboratory and the field, were conducted either with ground water from the area, pore water (for the consolidation tests), or distilled water. The use of distilled water as a permeant has been shown by Olson and Daniel (1981) to give a ratio of measured K to Correct K of about 5/1000 to 1/10.

The effects of a leachate stream on soil will depend primarily on the types and concentrations of chemicals or compounds present in the leachate, the pore water chemistry, the type of soil, the pH, and the effective stress of the soil. Anderson and Green (1981), Anderson, Brown and Green

(1982), and Green, Lee and Jones (1981) performed experiments which show that certain organic and inorganic chemicals react with clay soils and may cause increases or decreases in the coefficient of permeability of the soil. The experiments were performed in fixed-ring permeameters, on unsaturated samples, with permeants at 100 percent concentrations.

The effect of a leachate on a given soil cannot be evaluated from existing data. The only way to evaluate the effect of a leachate on a given soil would be to conduct permeability tests using the leachate as the permeant in the test.

METHODOLOGY

Two Shelby-tube samples were obtained from borings in the floor of the progressive trench area at the locations shown in Figure 1. The floor of the progressive trench was approximately 5 to 10 feet below the interface between the oxidized and unoxidized glacial tills at the location where the samples were obtained.

Two borings were advanced to a depth of about 5 feet using 4-inch-diameter continuous-flight augers. One Shelby-tube sample was obtained at the bottom of each of the two borings. PVC caps (snug fitting) were placed on each end of the Shelby tube and the ends were wrapped with duct tape.

The Shelby tubes were then placed in plastic bags, placed in coolers, packaged in Styrofoam, and shipped to the Woodward-Clyde Consultants' (WCC) soils laboratory in Overland Park, Kansas.

Three permeability tests were performed on 2-inch-diameter by 2-inch-high soil specimens trimmed from the Shelby-tube samples from the unoxidized zone. The permeability tests were performed in triaxial compression devices with backpressure saturation. One permeability test was performed with ground water from the BHS site. The other two permeability tests were performed first with ground water from the BHS site and then with leachate from organic trench 1N.

The soil specimens were trimmed to size from soil extruded from the two Shelby tubes and placed in double latex membranes in the triaxial cells. Ground water was used as the cell fluid to decrease the potential for the creation of an osmotic gradient across the sample membrane.

The soil samples were then backpressure saturated and the samples consolidated to an effective stress of 40 psi. The samples were allowed to consolidate for twenty-four hours prior to beginning the permeability test.

The first permeability test was conducted using ground water from well GM1 as the permeant. The hydraulic gradient was increased in increments and the coefficient of permeability was measured twice at each gradient. Figure 2 shows the relationship between hydraulic gradient and coefficient of permeability for the soil specimen. The axial and total volumetric deformation were monitored during consolidation and the permeability tests. The results show that negligible consolidation occurred at gradients of 50, 100, or 200. To facilitate recovery of data, subsequent permeability tests were performed with a gradient of 500 and the axial and total volumetric deformations were monitored for evidence of consolidation.

The permeability tests on samples BHS 2 and BHS 3 were set up identically to the test for sample BHS 1. After the sample was saturated and consolidated, the hydraulic gradient was increased to 500 and a permeability test was conducted using ground water from well GM1 as a permeant. The permeability tests were performed for approximately twenty-four hours with a ground water permeant. No discernable axial or volumetric deformations occurred in the soil specimen. Leachate was then introduced into the inflow lines and used as the permeant.

RESULTS

The results of the permeability tests for ground water and leachate are given in Figures 2, 3 and 4 for samples BHS 1, 2 and 3, respectively. The coefficient of permeability values for ground water for the three samples ranged from 7×10^{-9} cm/sec to 5×10^{-8} cm/sec. The introduction of leachate as the permeant caused no change in the coefficient of permeability of the soil specimen. For sample BHS 2, the ground water coefficient of permeability ranged from 8×10^{-9} cm/sec to 1×10^{-8} cm/sec. The coefficient of permeability of sample BHS 2 using leachate as the permeant ranged from approximately 7×10^{-9} cm/sec to 9×10^{-9} cm/sec. For sample BHS 3, the ground water coefficient of permeability ranged from 7×10^{-9} to 1×10^{-8}. The coefficient of permeability for sample BHS 3 using leachate as a permeant ranged from approximately 7 to 8×10^{-9} cm/sec.

CONCLUSIONS

The primary conclusions based upon the laboratory permeability and compatibility tests performed herein are presented below:

1. The leachate permeant from organic trench 1-N does not increase or decrease the coefficient of permeability of the unoxidized glacial till.
2. The coefficient of permeability measured in the triaxial permeability test of the unoxidized glacial till is in the range of approximately 5×10^{-9} to 5×10^{-8} cm/sec.
3. The results of the permeability tests performed in the triaxial compression devices are in the same range as the coefficient of permeability values calculated from the well inflow and outflow tests for the unoxidized glacial till.
4. Permeability tests performed in triaxial compression devices with back-pressure saturation are more likely to give representative values of coefficient of permeability than other types of laboratory permeability tests.

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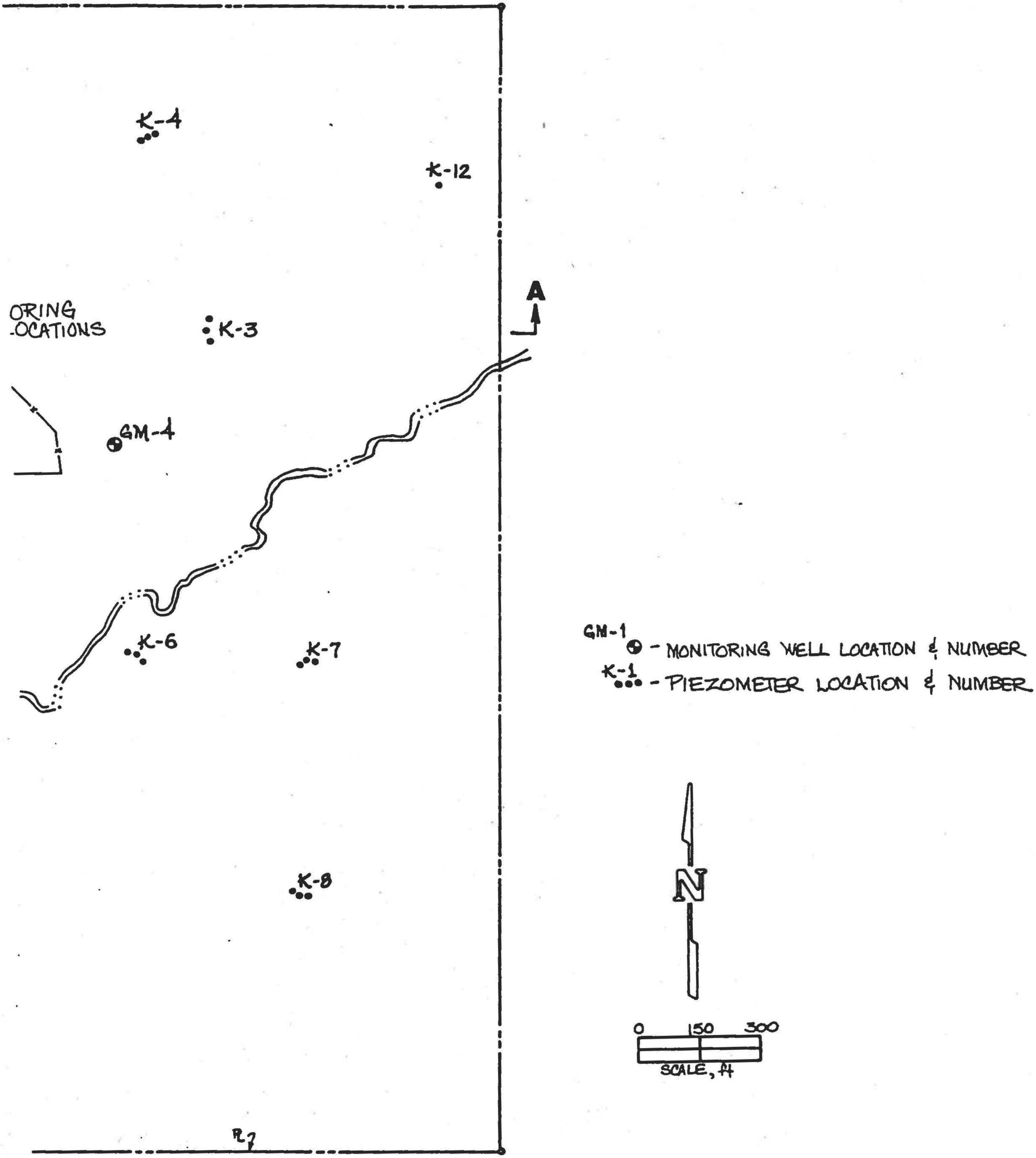
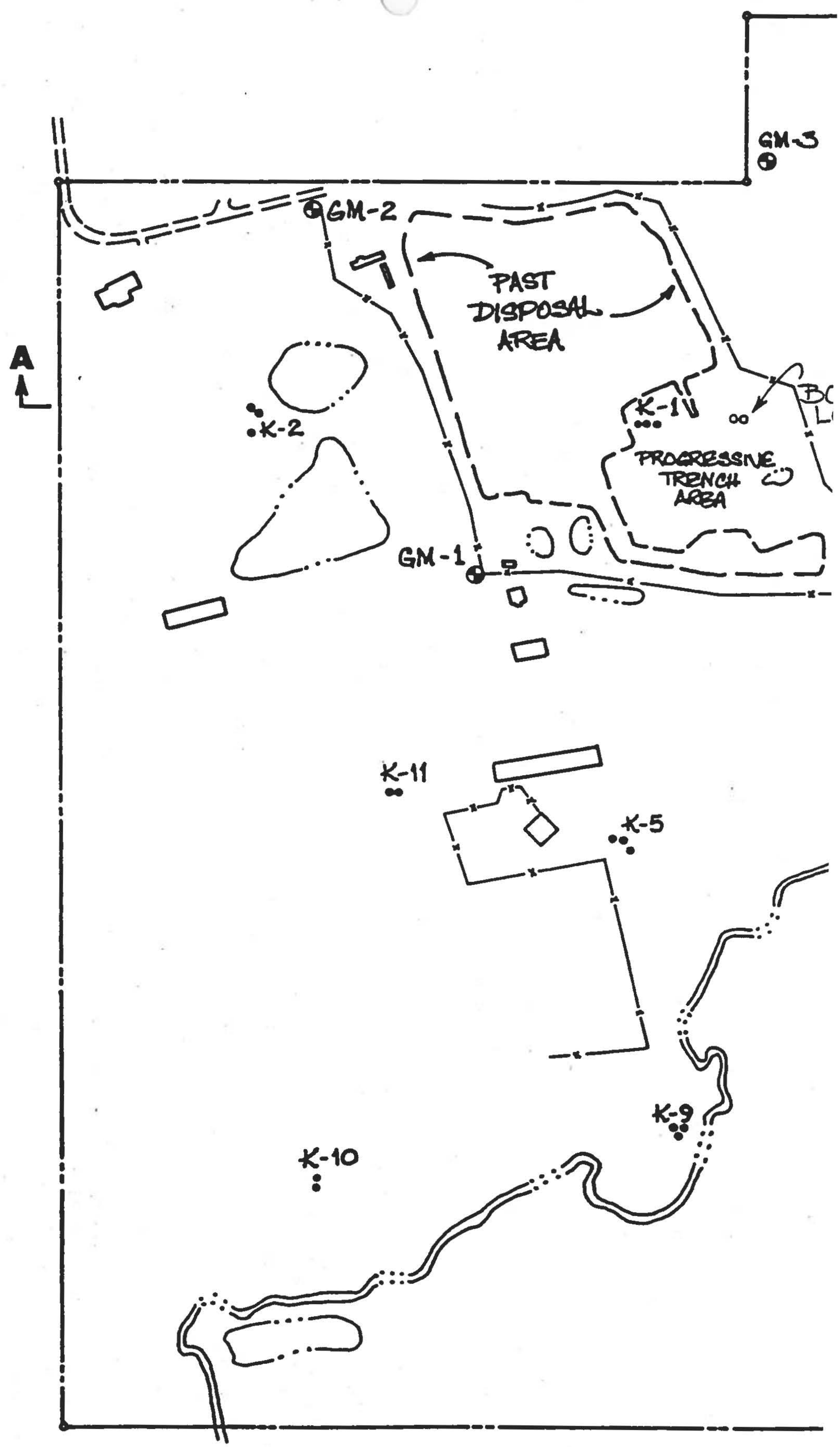

K-4
K-12
ORING
OCATIONS
K-3
A
GM-4
K-6
K-7
K-8
GM-1 - MONITORING WELL LOCATION & NUMBER
K-1 - PIEZOMETER LOCATION & NUMBER
N
0 150 300
SCALE, ft

FIGURE 1



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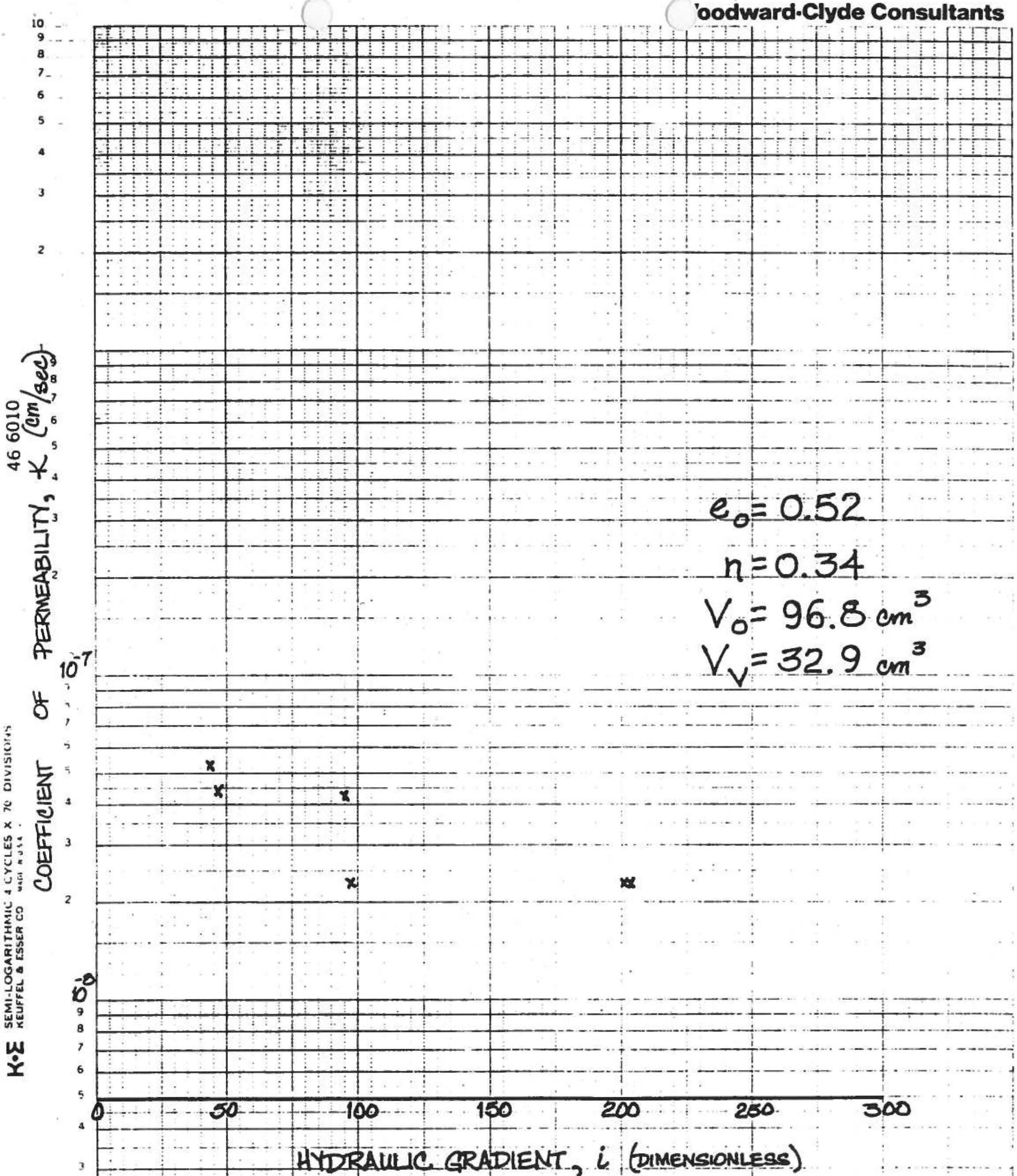
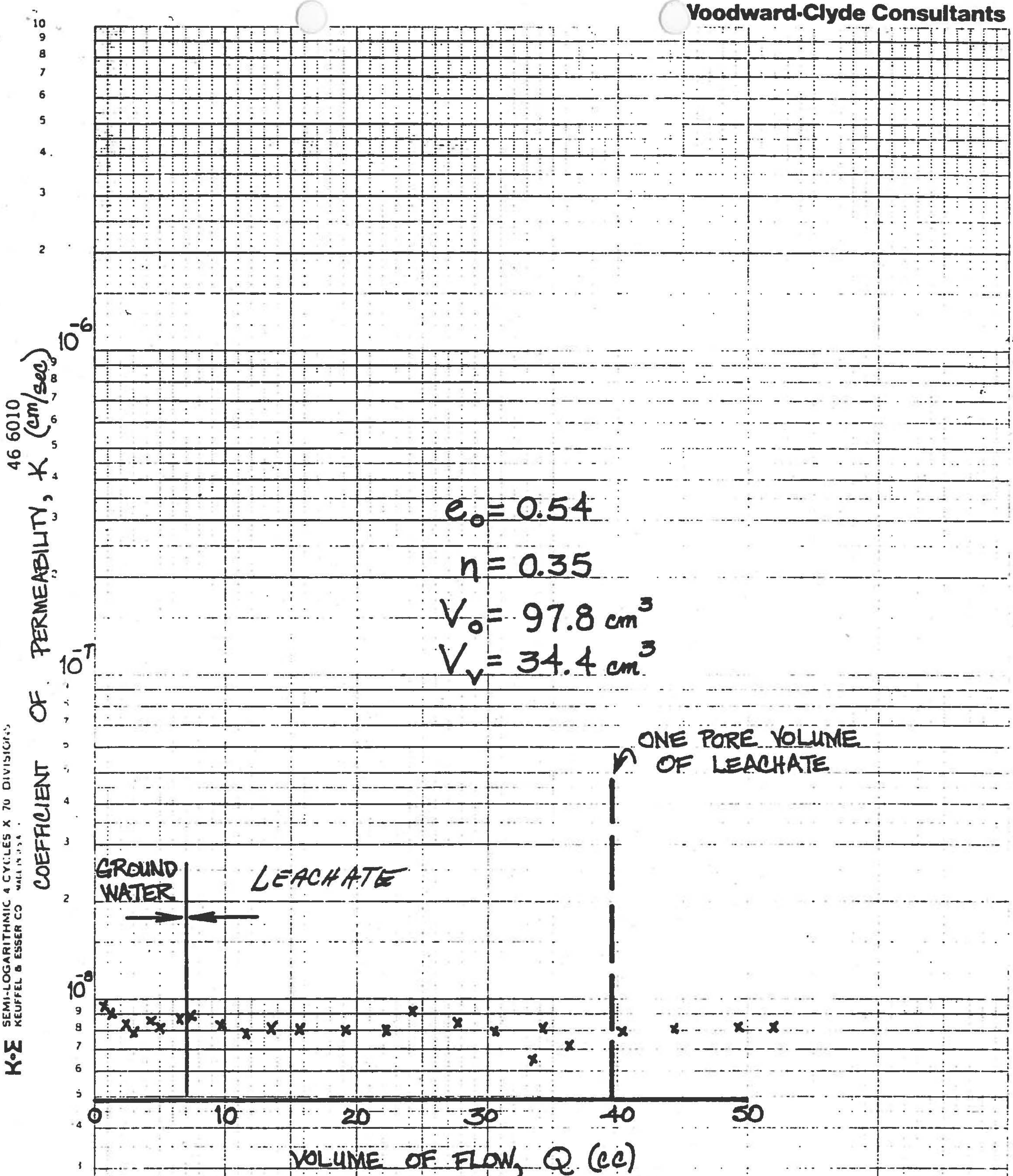


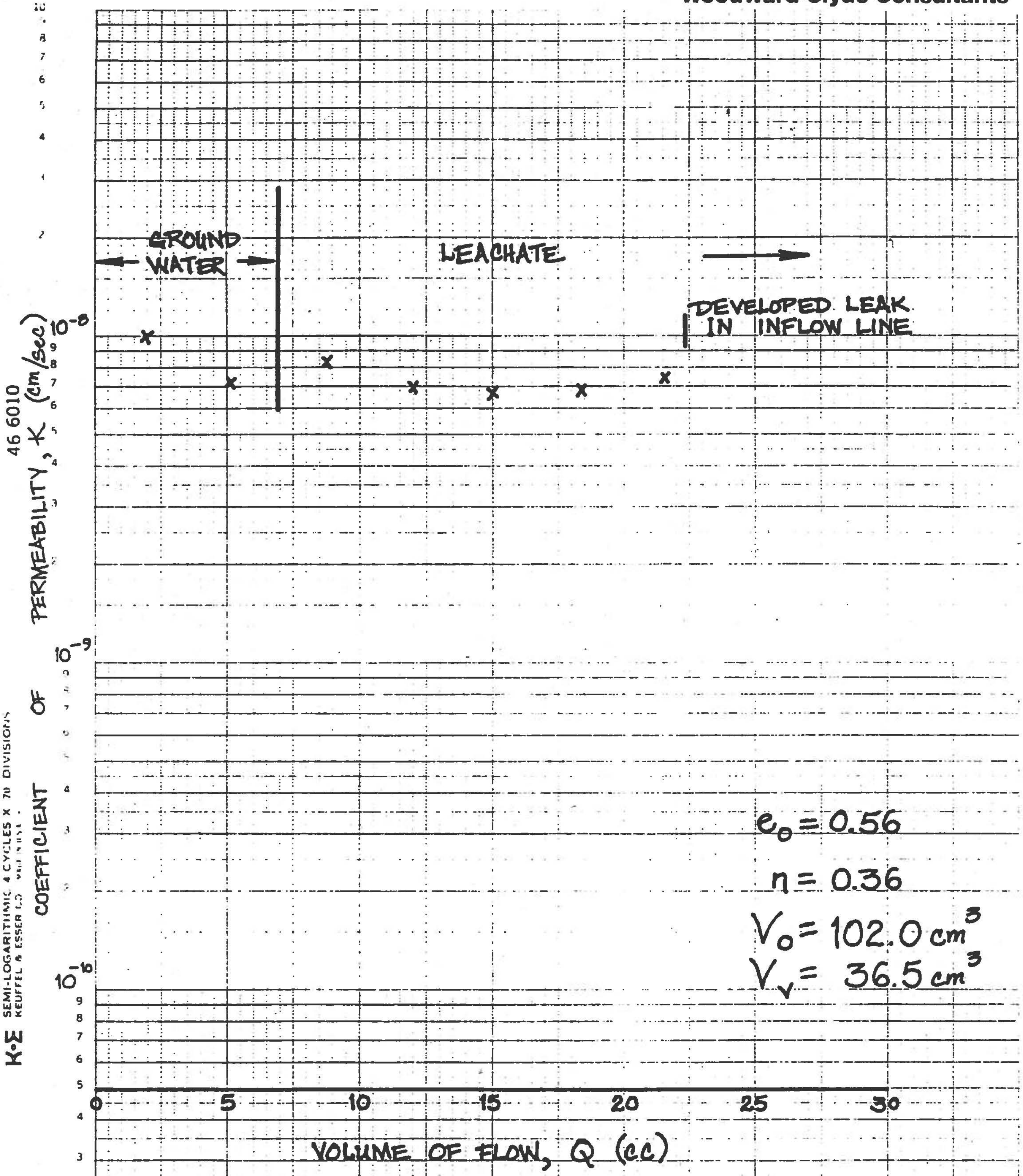
THE RELATIONSHIP BETWEEN
COEFFICIENT OF PERMEABILITY, K
AND THE HYDRAULIC GRADIENT, i,
FOR BHS 1 FOR GROUND WATER

FIGURE 2



COEFFICIENT OF PERMEABILITY, K,
FOR SAMPLE BHS 2 FOR
GROUND WATER AND LEACHATE

FIGURE 3



COEFFICIENT OF PERMEABILITY, K, FOR SAMPLE BHS 3 FOR GROUND WATER AND LEACHATE

FIGURE 4